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# Sinonasal Cancer and Occupation. Results from the Reanalysis of Twelve Case-Control Studies

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*A pooled reanalysis of twelve case-control studies on sinonasal cancer and occupation from seven countries was conducted in order to study associations with occupations other than wood- and leather-related occupations. The pooled data set included a total of 930 cases (680 men and 250 women) and 3,136 controls (2,349 men and 787 women). All the studies included a detailed occupational history for cases and controls. Each job was coded using the same classifications for occupation and industry. Two approaches were used in the analysis: systematic analysis of occupations; a priori analysis using a preestablished list of occupations and industries. The results confirmed associations observed in several studies not included in this analysis.*

- *For agricultural workers, significant excesses were observed for squamous cell carcinoma among women (OR=1.69) and men (OR=3.72 for ten years or more of employment as an orchard worker), and adenocarcinomas among men (OR=2.98 for ten years or more of employment).*
- *Associations with textile occupations were observed for adenocarcinoma among women (OR=2.60) and squamous cell carcinoma among men (OR=5.09 for fiber preparers, 3.01 for bleachers).*
- *Elevated risks for both histologic types were observed among men employed in food manufacturing (OR=3.25, adenocarcinoma), or as food preservers (OR=13.9, squamous cell carcinoma), and among men employed as cooks (OR=1.99, squamous cell carcinoma).*
- *A positive association with squamous cell carcinoma was observed for male transport equipment operators (OR=1.21), and also with adenocarcinoma for male motor-vehicle drivers (OR=2.50).*

*A number of other associations were observed in the systematic analysis.* Am. J. Ind. Med. 31:153–165, 1997. *© 1997 Wiley-Liss, Inc.*

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## INTRODUCTION

An association between employment in wood-related, and, to a lesser extent, leather-related occupations and the risk of sinonasal cancer has been well documented [Pippard and Acheson, 1985; Merler et al., 1986; Demers et al., 1995; IARC, 1995]. However, associations with sinonasal cancer have been observed with a number of other occupational groups, including farmers and agricultural workers [Ng, 1986; Takasaka et al., 1987; Olsen, 1988; Bimbi et al., 1988], fishermen [Ng, 1986], textile workers [Acheson et al., 1981; Brinton et al., 1985; Malker et al., 1986; Ng, 1986; Bimbi et al., 1988; Comba et al., 1992], bakers and pastry cooks [Acheson et al., 1981; Malker et al., 1986; Luce et al., 1992], food processors [Malker et al., 1986; Olsen, 1988], workers in metal industry [Acheson et al., 1981; Bimbi et al., 1988; Olsen, 1988; Comba et al., 1992], foundry workers [Acheson et al., 1981; Comba et al., 1992], plumbers and welders [Hernberg et al., 1983], coal miners [Acheson et al., 1981], construction workers [Ng, 1986; Comba et al., 1992; Luce et al., 1992], transport and communication workers [Malker et al., 1986], chemical manufacturing workers [Brinton et al., 1984]. Few cohort studies have the power needed to demonstrate associations with this rare disease. Although many case-control studies have been performed, they generally included a small number of cases, which has limited the ability to examine associations with specific jobs. The results presented here are based on a pooled reanalyses of twelve case-control studies which include a total of 930 cases and 3,135 controls. Results on wood-related occupations from the same data set have been published in a previous paper [Demers et al., 1995] and similar analyses have been carried out for leather-related occupations. The present report focused on occupational associations for which the evidence is less clear.

## METHODS

### Participating Studies

The pooled data set included 12 studies from seven countries. The studies were selected according to the following inclusion criteria: that histology was known for cases; that age, sex and smoking information was available for both cases and controls; and that occupational histories had been collected from patients (or their survivors) and controls by interview or questionnaire.

Details on the studies are presented in Table I. The 680 male cases included 330 squamous cell cancers, 169 adenocarcinomas, 156 of other histology, and 25 of unknown histology. All but two studies included women. The 250 female cases included 102 squamous cell cancers, 26 adenocarcinomas, 104 of other histology, and 18 of unknown histology. There were 2,349 male controls and 787 female controls. The studies differed in recruitment of cases and controls (hospital- or population-based source), the type of interview (personal, telephone, or mail), and the vital status of subjects (inclusion or exclusion of deceased subjects). The years of diagnosis of the cases ranged from 1968 to 1990. The delay between diagnosis and interview varied according to the studies; some studies included only recent cases, others included cases diagnosed several years before interview. The control to case ratio ranged from 1 to 12.

### Occupational Histories

All the studies included a detailed occupational history for cases and controls with job titles and year of beginning and year of end for each job. Each job was coded using the 1968 International Standard Classification of Occupations (ISCO) of the International Labour Organisation for occupational titles and the United Nations International Standard Industrial Classification (ISIC) codes for industry titles. The coding was done directly from the questionnaires for eight studies. Four studies (Los Angeles, Seattle, Shanghai, Sweden) were previously coded using a different system and for these studies, re-coding was performed from the coding system originally used.

### Analysis

Two approaches were used in the analysis:

— *systematic analysis:* analysis of associations with all 1- or 2-digit ISCO codes, except for farmers and agricultural workers, who were grouped according to the agricultural and animal husbandry products (a list of the ISCO codes is provided in Table II).
— *a priori analysis:* analysis for specific occupations and industries, using a pre-established list of suspected occupations and industries, according to the literature (a list of the occupations and industries is provided in Table III).

Separate analyses were performed for men and women, and for squamous cell carcinomas and adenocarcinomas. Other histologic types were not studied because the categories coded were not comparable between studies. All analyses were performed using logistic regression with the BMDP software (University of California Press, Berkeley, California). Preliminary analyses of this data set found that smoking was related to squamous cell cancers, but not to adenocarcinomas. However, introduction of cigarette smoking into the models, in addition to age and study, had no appreciable effect. As a consequence, all results are presented adjusted only for study and age category (55 or less; 56–65; 66 and over).

**TABLE I.** Design of the Twelve Studies Examining Sinonasal Cancer and Occupation

| Study, main reference of the study | Cases and controls sex | Year of interview | Year or diagnosis, cases | Vital status | Source of cases | Source of controls | Type of interview |
|---|---|---|---|---|---|---|---|
| Seattle, USA, Vaughan | 53 Cases<br>552 Controls | 79–85 | 79–83 | Mostly Alive | Population based registry | Random digit dialing | Telephone |
| Los Angeles, USA, Preston-Martin | 102 Cases<br>178 Controls | 79–85 | 79–85 | Alive | Population based registry | Population (neighborhood) | Telephone |
| Virginia, USA, Brinton | 160 Cases<br>287 Controls | 80–82 | 70–80 | Alive and Deceased | Hospitals | Alive hospital controls for alive cases. Different sources for dead cases | Telephone |
| Verona, Siena, Italy, Comba | 78 Cases<br>254 Controls | 87–88 | 82–87 | Alive and Deceased | Hospitals | Hospital | -Personal<br>-Mail<br>-Telephone<br>-Mail + tel |
| Brescia, Italy, Comba | 34 Cases<br>102 Controls | 90 | 80–89 | Alive and Deceased | Hospital | Hospital | Telephone |
| Biella, Italy Magnani | 26 Cases<br>111 Controls | 88–89 | 76–88 | Alive and Deceased | Population | Hospital | Mail + telephone |
| Vigevano, Italy, Merler | 21 Cases<br>39 Controls | 83 | 68–82 | Alive and Decreased | Population based, different hospitals | Electoral rolls Mortality rolls | Personal |
| France, Luce | 207 Cases<br>409 Controls | 86–88 | 86–88 | Alive | Hospitals | 2 control groups:<br>-Hospital<br>-Population | Personal |
| Netherlands, Hayes | 91 Cases<br>195 Controls (men only) | 82 | 78–81 | Alive and Deceased | Hospitals | Population<br>City registries<br>Deaths registries | Mostly personal |
| Germany, Bolm-Audorff | 54 Cases<br>54 Controls | 83–85 | 83–85 | Alive | Hospitals | Hospitals | Personal |
| Sweden, Hardell | 44 Cases<br>541 Controls (men only) | 79 | 70–79 | Alive and Deceased | Population based, registry | Different sources | Mail |
| Shanghai, China Zheng | 60 Cases<br>414 Controls | 88–90 | 88–90 | Alive | Population based, registry | Resident registry | Personal |
| Total | 930 Cases<br>3136 Controls | | | | | | |

For each occupation, odds ratios (ORs) were calculated for ever versus never employment in that particular occupation. Odds ratios were also calculated according to duration of employment, using a variable with three categories: never employed (reference category); employed less than ten years; and employed ten years or more. An induction-latency period was taken into account by excluding the last 10 or 20 years of employment before a reference date. Odds ratios were not calculated if there were less than three exposed cases.

For adenocarcinoma, the analysis was restricted to cases and controls never employed in a wood or leather occupation in order to avoid bias due to wood or leather dust exposure. The occupations classified as wood-related were the same as used in the previously published paper from this collaborative project: ISCO codes 631, 632 (logger, forestry workers); 73190, 732, 97950 (sawmill workers) 733, 734, 91 (pulp and paper workers); 81 (cabinet makers and related woodworkers); 71160, 954, 95910, (carpentry workers); ISIC codes 121 (forestry), 122 (logging), 33 (manufacture of wood products), 341 (manufacture of paper products). Occupations classified as leather dust exposed were ISCO codes 76 (tanners, fellmongers and pelt dressers), 792 (fur tailors), 80 (shoemakers, leather goods makers), 94930 (taxidermists) and ISIC codes 323–324 (manufacture of leather products) and 9511 (repairing of shoes and other leather products).

**TABLE II.** Occupations in the Systematic Analysis of Studies of Sinonasal Cancer

| ISCO code | Short name | |
|---|---|---|
| 11 | Accountants | Accountants |
| 13 | Teachers | Teachers |
| 14 | Religion workers | Workers in religion |
| 16 | Artists | Sculptors, painters, photographers, and related artists |
| 19 | Professionals | Professional, technical, and related workers n.e.c. |
| 2 | Administrative | Administrative and managerial workers |
| 21 | Managers | Managers |
| 3 | Clerical workers | Clerical and related workers |
| 30 | Clerical supervisors | Clerical supervisors |
| 31 | Government executives | Government executive officials |
| 32 | Typists | Stenographers, typists, card- and tape-punching machine operators |
| 33 | Bookkeepers | Bookkeepers, cashiers and related workers |
| 37 | Mail | Mail distribution clerks |
| 39 | Clerk | Clerical and related workers n.e.c. |
| 40 | Managers | Managers (wholesale and retail trade) |
| 41 | Proprietors | Working proprietors (wholesale and retail trade) |
| 42 | Sales supervisors | Sales supervisors and buyers |
| 43 | Sales-travelers | Technical salesmen, commercial travelers, and manufacturers' agents |
| 44 | Insurance | Insurance, real estate, securities and business services salesmen, auctioneers |
| 45 | Sales | Sales persons, shop assistants, and related workers |
| 50 | Managers-cat. | Managers (catering and lodging services) |
| 51 | Prop-cat. | Working proprietors (catering and lodging services) |
| 53 | Waiters | Cooks, waiters, bartenders, and related workers |
| 54 | Maids | Maids and related housekeeping service workers n.e.c. |
| 55 | Charworkers | Building caretakers, charworkers, cleaners, and related workers |
| 56 | Launderers | Launderers, dry-cleaners, and pressers |
| 57 | Hairdressers | Hairdressers, barbers, beauticians and related workers |
| 58 | Protective service | Protective service workers |
| 59 | Service | Service workers n.e.c. |
| 611 + 621 | Farm, general | General farmers and farm workers |
| 61220 + 622 | Farm, field crop | Field crop farmers and workers |
| 61230 + 623 | Farm, orchard | Orchard, vineyard farmers, and workers |
| 61240 + 624 | Farm, livestock | Livestock farmers and workers |
| 61250 + 625 | Farm, dairy | Dairy farmers and farm workers |
| 61260 + 626 | Farm, poultry | Poultry farmers and farm workers |
| 61270 + 627 | Farm, nursery | Horticultural farmers, nursery workers, and gardeners |
| 628 | Farm machin. | Farm machinery operators |
| 61290 + 629 | Farm, other | Other farmers and farm workers |
| 63 | Forestry | Forestry workers |
| 70 | Foremen | Production supervisors and general foremen |
| 71 | Min, quarry and rel. | Miners, quarrymen, well drillers, and related workers |
| 72 | Metal | Metal processers |
| 73 | Wood preparation | Wood preparation workers and paper makers |
| 74 | Chemical | Chemical processers and related workers |
| 75 | Textile | Spinners, weavers, knitters, dyers, and related workers |
| 76* | Leather | Tanners, fellmongers, and pelt dressers |
| 77 | Food processors | Food and beverage processers |
| 79 | Tailors | Tailors, dressmakers, sewers, upholsterers, and related workers |
| 80* | Shoemakers | Shoemakers and leather goods makers |
| 81* | Cabinetmakers | Cabinetmakers and related wood workers |

**TABLE II.** Occupations in the Systematic Analysis (continued)

| ISCO code | Short name | |
|---|---|---|
| 83 | Blacksmiths | Blacksmiths, toolmakers, and machine-tool operators |
| 84 | Machine fitters | Machinery fitters, machine assemblers, and precision instrument makers (except electrical) |
| 85 | Electrical fitters | Electrical fitters and related electrical and electronics workers |
| 87 | Plumbers, welders | Plumbers, welders, sheet metal and structural metal preparers and erectors |
| 89 | Glass | Glass formers, potters and related workers |
| 90 | Rubber, plastic | Rubber and plastics product makers |
| 92 | Printers | Printers and related workers |
| 93 | Painters | Painters |
| 94 | Production workers | Production and related workers n.e.c. |
| 95 | Construction | Bricklayers, carpenters and other construction workers |
| 96 | Stationary engineers | Stationary engine and related equipment operators |
| 97 | Dockers | Material-handling and related equipment operators, dockers and freight handlers |
| 98 | Transport | Transport equipment operators |
| 99 | Laborers | Laborers n.e.c. |

*Not studied for adenocarcinoma.

**TABLE III.** Reanalysis of Sinonasal Cancer Studies—A priori Suspected Occupations and Industries

| | Short name | |
|---|---|---|
| ISCO code | | |
| 531 | Cooks | Cooks |
| 711 | Miners, quarry | Miners and quarrymen |
| 71105 | Miners | Miners (general) |
| 751 | Fiber preparers | Fiber preparers |
| 752 | Spinners | Spinners and winders |
| 754 | Weavers | Weavers and related workers |
| 755 | Knitters | Knitters |
| 756 | Bleachers | Bleachers, dyers, and textile product finishers |
| 773 | Butchers | Butchers and meat preparers |
| 774 | Food preservers | Food preservers |
| 776 | Bakers | Bakers, pastrycooks, and confectionery makers |
| 871 | Plumbers | Plumbers and pipe fitters |
| 872 | Welders | Welders and flame-cutters |
| 931 | Painters, const. | Painters, construction |
| 93120 | Building painters | Building painters |
| 939 | Painters n.e.c. | Painters n.e.c. |
| 951 | Bricklayers | Bricklayers, stonemasons, and tile setters |
| 985 | Motor vehic. driv. | Motor-vehicle drivers |
| 99930 | Laborers, const. | Laborers, construction |
| ISIC code | | |
| 111 | Agriculture | Agricultural and livestock production |
| 311–312 | Food | Food manufacturing |
| 321–322 | Textile | Manufacture of textiles, wearing apparel, except footwear |
| 5000 | Construction | Construction |

In the systematic analysis, if the results suggested an association with the disease they were investigated more closely. The distribution of exposed cases and controls among studies was examined in order to see whether the results of individual studies were consistent with the pooled results. The detailed codes for occupation and activity branches of cases and controls were also described. The criteria for a more comprehensive analysis of the results concerning a given occupation from the systematic analysis were as follows:

— a statistically significant or borderline OR for ''ever employed'' (lower limit of the 95% confidence interval $\geq 0.85$ or upper limit $\leq 1.15$); or
— a significant OR for ''ever employed'' with an induction period of 10 or 20 years; or
— a significant OR for employment duration $\geq 10$ years.

## RESULTS

### Squamous Cell Carcinoma

For the systematic analysis, 58 occupations having at least three exposed cases were examined for men while 18 occupations met the same criteria for women. Table IV presents the detailed results for the analyses of 13 occupations for which the results suggested an association with sinonasal squamous cell carcinoma among either men or women. The results for the remaining occupations can be found in the Appendix.

Several associations were noted among professional, technical, and related workers. A strong association was observed for female accountants (ISCO code 11), based on

**TABLE IV.** Associations Between Selected Occupations and Squamous Cell Carcinoma—Systematic Analysis[1]

| | | Males (330 cases, 2349 controls) | | | | | Females (102 cases, 787 controls) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ever employed | | | OR employment duration | | Ever employed | | | OR employment duration | |
| ISCO code | Short name | Cases/controls | OR | 95% CI | <10 Yrs | ≥10 yrs | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs |
| 11 | Accountants | 3/36 | 0.91 | 0.27–3.12 | 1.39 | 0.54 | 3/10 | 10.7 | 2.34–49.1 | 17.4* | 5.95 |
| 13 | Teachers | 7/88 | 0.49 | 0.22–1.09 | 0.54 | 0.47 | 2/55 | [2] | | [2] | |
| 16 | Artists | 4/12 | 2.82 | 0.83–9.58 | 1.16 | 4.50* | 0/8 | [2] | | [2] | |
| 19 | Professional | 7/31 | 2.15 | 0.88–5.21 | 3.27* | 1.21 | 3/14 | 2.18 | 0.55–8.59 | 5.79* | 0 |
| 21 | Managers | 28/184 | 1.14 | 0.72–1.79 | 1.05 | 1.20 | 8/31 | 2.76 | 1.11–6.82 | 3.57* | 1.95 |
| 45 | Sales | 39/211 | 1.26 | 0.86–1.85 | 1.54 | 0.98 | 18/122 | 1.32 | 0.73–2.40 | 1.68 | 0.77 |
| 57 | Hairdressers | 6/13 | 2.87 | 1.03–8.02 | 17.2* | 2.21 | 0/15 | [2] | | [2] | |
| 61230 + 623 | Farm, orchard | 6/14 | 2.49 | 0.93–6.71 | 0.79 | 3.72* | 1/16 | [2] | | [2] | |
| 71 | Mine, quarry and related | 15/85 | 1.54 | 0.86–2.77 | 1.18 | 1.87 | 0/0 | [2] | | [2] | |
| 77 | Food processors | 22/107 | 1.38 | 0.85–2.26 | 1.35 | 1.39 | 0/27 | [2] | | [2] | |
| 90 | Rubber, plastic | 7/23 | 3.17* | 1.28–7.86 | 2.17 | 3.53 | 1/8 | [2] | | [2] | |
| 96 | Stationary engineers | 7/37 | 1.55 | 0.66–3.67 | 0.45 | 3.39* | 0/0 | [2] | | [2] | |
| 98 | Transport | 55/321 | 1.21 | 0.87–1.68 | 1.16 | 1.33 | 1/9 | [2] | | [2] | |

*Significantly different from 1.
[1]See the text. For other results, see Appendix 1.
[2]Not calculated, fewer than three cases.

only three cases, all of them from the Chinese study. For male sculptors, painters, photographers, and related creative artists (ISCO code 16), a significantly increased OR was observed for ten years and more of employment (OR = 4.50, 95% CI = 1.07–18.9). The four exposed cases were from three different studies. When more detailed job titles were examined, the excess was limited to the code 162 ''commercial artists and designers.'' An elevated OR among men and women was observed for professional, technical and related workers not elsewhere classified (ISCO code 19). However, the significant excess among both men and women was limited to an employment duration less than ten years. The only occupation for which a protective effect was suggested was male teachers (ISCO code 13). However, the OR was not significantly different from 1 at a 5% level.

Some excesses were also observed among administrative, sales, and service workers. An excess among women managers (ISCO code 21) was observed based on eight cases and 31 controls. Five cases came from the Los Angeles study (crude OR = 4.67); there was no association with specific activity branches, since most jobs were classified in social services. For salesmen, shop assistant, and related workers (ISCO code 45) the OR was elevated but not significant. A limited excess (crude OR between 1.3 and 1.75) was observed in the largest studies (Seattle, Virginia, France, Netherlands, Sweden). The activity branch was ''wholesale'' or ''retail sale'' for a large majority of subjects. A similar excess was observed among women employed in sales occupations. For male hairdressers (ISCO code 57), a significant excess based on six cases was observed, although the risk did not increase with duration of exposure. The excess of cases originated from four studies (Virginia, Verona-Siena, France, China).

Excesses suggestive of an association were also observed for agricultural, mining, and industrial occupations. An excess risk was observed for male orchard, vineyard, and related tree and shrub crop farmers and workers (codes 61230 + 623) with a significant excess for a duration of exposure of ten years or more. An elevated but not significant OR was observed for ISCO code 71, which includes miners and quarrymen. The corresponding industries among cases and controls were equally distributed between coal mining (ISIC code 210), metal ore mining and other mining. Among the 15 exposed cases, five came from the Swedish study (crude OR = 2.36) and four from the French study (crude OR = 2.17). A small excess was observed for food and beverage processors (ISCO code 77). A significant excess was observed for rubber and plastic product makers (ISCO code 90, seven cases and 23 controls). The number of exposed cases did not exceed two in any of the studies. Three cases and two controls were classified in tire manufacturing, according to the 5-digit codes. For stationary engine and related equipment operators (ISCO code 96), a significantly elevated OR was observed for ten years or more of employment (OR = 3.39,

**TABLE V.** Associations Between Occupation and Squamous Cell Carcinoma—A priori Suspected Occupations and Industries

| | | Males (330 cases, 2349 controls) | | | | | Females (102 cases, 787 controls) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ever employed | | | OR employment duration | | Ever employed | | | OR employment duration | |
| | Short name | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs |
| ISCO code | | | | | | | | | | | |
| 531 | Cook | 14/45 | 1.99* | 1.04–3.83 | 2.72* | 1.25 | 3/47 | 0.51 | 0.15–1.77 | 0.27 | 0.69 |
| 711 | Miners, quarry | 13/80 | 1.38 | 0.74–2.58 | 1.13 | 1.52 | 0/0 | [1] | | [1] | |
| 71105 | Miners | 7/52 | 1.04 | 0.46–2.37 | 1.11 | 1.06 | 0/0 | [1] | | [1] | |
| 751 | Fiber preparers | 4/10 | 5.09* | 1.34–19.2 | 13.5* | 0 | 0/10 | [1] | | [1] | |
| 752 | Spinners | 3/26 | 0.70 | 0.20–2.41 | 0.76 | 1.18 | 4/34 | 0.76 | 0.25–2.28 | 0.74 | 1.06 |
| 754 | Weavers | 6/23 | 1.51 | 0.59–3.86 | 1.85 | 1.03 | 4/28 | 1.29 | 0.41–4.08 | 2.76 | 0.57 |
| 755 | Knitters | 1/6 | [1] | | [1] | | 3/13 | 1.74 | 0.45–6.69 | 2.14 | 1.79 |
| 756 | Bleachers | 5/13 | 3.01* | 1.00–9.08 | 3.99 | 2.13 | 1/2 | [1] | | [1] | |
| 773 | Butchers | 6/30 | 1.31 | 0.53–3.27 | 2.31 | 0.73 | 0/4 | [1] | | [1] | |
| 774 | Food preservers | 4/2 | 13.9* | 2.29–84.4 | 6.90 | ∞ | 1/12 | [1] | | [1] | |
| 776 | Bakers | 7/49 | 0.99 | 0.43–2.26 | 0.96 | 0.88 | 0/5 | [1] | | [1] | |
| 871 | Plumbers | 4/32 | 0.89 | 0.30–2.60 | 0.50 | 0.97 | 0/0 | [1] | | [1] | |
| 872 | Welders | 6/59 | 0.92 | 0.38–2.22 | 0.69 | 1.33 | 2/6 | [1] | | [1] | |
| 931 | Painters, const. | 5/33 | 0.98 | 0.37–2.60 | 0 | 1.76 | 0/1 | [1] | | [1] | |
| 93120 | Building painters | 5/31 | 1.11 | 0.42–2.95 | 0 | 1.76 | 0/0 | [1] | | [1] | |
| 939 | Painters n.e.c. | 3/27 | 0.69 | 0.20–2.37 | 0 | 1.25 | 0/4 | [1] | | [1] | |
| 951 | Bricklayers | 16/78 | 1.31 | 0.74–2.33 | 1.40 | 1.43 | 0/1 | [1] | | [1] | |
| 985 | Motor vehicle driver | 41/251 | 1.13 | 0.78–1.63 | 1.15 | 1.22 | 1/7 | [1] | | [1] | |
| 99930 | Laborers, const. | 10/37 | 1.29 | 0.62–2.68 | 1.55 | 1.44 | 0/0 | [1] | | [1] | |
| ISIC code | | | | | | | | | | | |
| 111 | Agriculture | 98/563 | 1.14 | 0.87–1.50 | 1.26 | 1.14 | 23/90 | 1.69 | 0.96–2.97 | 1.20 | 1.62 |
| 311–312 | Food | 28/155 | 1.14 | 0.74–1.77 | 0.76 | 1.80* | 1/57 | [1] | | [1] | |
| 321–322 | Textile | 29/179 | 1.17 | 0.75–1.83 | 1.02 | 1.43 | 22/140 | 1.18 | 0.68–2.03 | 1.90 | 0.92 |
| 5000 | Construction | 69/510 | 0.97 | 0.72–1.31 | 1.00 | 0.99 | 2/18 | [1] | | [1] | |

*Significantly different from 1.
[1]Not calculated, fewer than three cases.

95% CI = 1.14–10.1). The most frequent 5-digit code was ''boiler, fireman'' among both cases and controls. Finally, for transport equipment operators (ISCO code 98), the OR for ''ever employed'' was slightly elevated, but not significantly so.

Table V presents the squamous cell carcinoma results for the 23 a priori suspected occupations and industries with a sufficient number of cases for analysis. For male cooks (ISCO code 531) a significant increase in risk was observed. The OR remained significant with an induction period of ten years, but was no longer significant when a 20-year induction period was taken into account. The excess was stronger for an employment duration of less than ten years. The crude ORs were above two in five studies (Los Angeles, Virginia, Verona-Siena, Netherlands, China). No association was observed among women cooks.

Among occupations in textile manufacturing (2-digit ISCO code 75, ISIC codes 321–322) significantly elevated ORs were observed for fiber preparers (ISCO 751, four exposed cases) and bleachers, dyers, and textile product finishers (ISCO 756, five exposed cases); an excess for one of these codes, or both, was observed in more than half of the studies, even though the number of exposed cases was small. However, the excess risk for fiber preparers was restricted to subjects with less than ten years of exposure. No clear pattern emerged for women textile manufacturing workers and textile garment makers (ISCO codes 75 and 79, ISIC codes 321–322).

Results for food and beverage processors (ISCO code 77, Table IV) and food manufacturing (ISIC codes 311–312) indicated a limited increase in risk; the association was stronger for one subcategory, food

**TABLE VI.** Associations Between Selected Occupations and Adenocarcinoma—Systematic Analysis[1]

| | | Males[2] (33 cases, 1707 controls) | | | | | Females[2] (23 cases, 727 controls) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ever employed | | | OR employment duration | | Ever employed | | | OR employment duration | |
| ISCO code | Short name | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs |
| 43 | Sales-travel. | 4/57 | 4.97* | 1.60–15.4 | 3.05 | 8.69* | 0/8 | [3] | | [3] | |
| 611 + 621 | Farm, general | 6/293 | 1.22 | 0.47–3.15 | 3.71* | 0.41 | 3/49 | 1.22 | 0.33–4.48 | 1.37 | 0.71 |
| 77 | Food processors | 4/83 | 3.25* | 1.06–9.92 | 3.69 | 3.53 | 1/26 | [3] | | [3] | |
| 98 | Transport | 8/217 | 2.18 | 0.95–5.01 | 2.95* | 0.62 | 0/8 | [3] | | [3] | |

*Significantly different from 1.
[1]See the text. For other results, see Appendix 2.
[2]Never employed in a wood- or leather-related occupation.
[3]Not calculated, fewer than 3 cases.

preservers (ISCO code 774, four exposed cases and two controls). Two of the cases, and no control, had been employed ten years or more. Three studies (Seattle, France, Netherlands) had at least one case.

An excess was observed among women employed in agriculture (ISIC code 111). Crude ORs larger than 1.5 were observed in six studies. Less consistent results were observed for men, although an excess was observed among orchard workers in the systematic analysis (Table IV).

## Adenocarcinoma

A total of 169 male cases of adenocarcinoma were included in the study, among which only 33 had never been employed in a wood- or leather-related occupation. These 33 cases were compared to the 1,707 controls fulfilling the same criteria (out of a total of 2,349 male controls). For females, restricting cases and controls to subjects never employed in a wood- or leather-related occupation reduced only slightly the number of subjects, from 26 to 23 among cases and from 787 to 727 among controls.

Eight ISCO codes for men and three for women had at least three exposed cases and were included in the systematic analysis. Among these 11 occupations, four (all of them for men) suggested an association with adenocarcinoma (Table VI). A significant excess was observed for male technical salesmen, commercial travelers, and manufacturer's agents (ISCO code 43). A significantly elevated odds ratio was also observed for food and beverage processors (ISCO code 77), based on four cases (from four different countries) and 83 controls. The 3-digit ISCO codes were butchers and meat preparers (one case, 23 controls), food preservers (one case, one control), and bakers, pastry cook (two cases, 44 controls). There were also excesses among general farmers and farm workers (ISCO codes 611 and 621) and among transport equipment operators (ISCO code 98), which were limited to men employed for less than ten years. The results for the remaining occupations examined in the systematic analysis can be found in the Appendix.

Six a priori suspected occupations and industries had a sufficient number of exposed cases among either men or women to be studied. Four of these categories had results which were suggestive of an association with adenocarcinoma (Table VII). For women, a significant association with the disease, based on nine cases, was observed for workers employed in the textile industry (ISIC code 321–322). For weavers and related workers (ISCO code 754) the increase for ''ever employed'' limited to subjects exposed less than ten years was based on three cases who came from the same study (Virginia). Consistent with the results for transport equipment operators (ISCO code 98), motor-vehicle drivers (ISCO code 985) had a significantly elevated OR. The excess was limited to drivers employed for less than ten years. Among the seven cases with the ISCO code 985 (motor-vehicle drivers) four came from the same study (Virginia). Among a prior suspected industries, for men, only for agriculture (ISIC code 111) a significant association was observed. In contrast to the analyses for general farmers or farm workers in the systematic analysis (ISCO 611+621), the highest excess was for the longest duration of exposure (based on two cases).

## DISCUSSION

A potential limitation of this pooled reanalysis of different case-control studies is the potential for bias due to the differences between the individual studies. One potentially significant difference is the methods by which the work history was coded. Some non-differential misclassification of occupations may have occurred, especially since the coding of occupation in some studies could not be done

**TABLE VII.** Associations Between Occupation and Adenocarcinoma—A priori Suspected Occupations and Industries

| | | Males[1] (33 cases, 1707 controls) | | | | | Females[1] (23 cases, 727 controls) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ever employed | | | OR employment duration | | Ever employed | | | OR employment duration | |
| | Short name | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs | Cases/controls | OR | 95% CI | <10 yrs | ≥10 yrs |
| ISCO code | | | | | | | | | | | |
| 754 | Weavers | 0/20 | [2] | | [2] | | 3/27 | 3.96 | 0.97–16.2 | 10.8* | 0 |
| 985 | Motor vehicle driver | 7/162 | 2.50* | 1.03–6.10 | 3.29* | 0.80 | 0/7 | [2] | | [2] | |
| ISIC code | | | | | | | | | | | |
| 111 | Agriculture | 8/416 | 0.98 | 0.42–2.30 | 1.92 | 2.98* | 6/85 | 1.47 | 0.53–4.07 | 1.00 | 0.64 |
| 311–312 | Food | 4/115 | 2.20 | 0.73–6.66 | 2.29 | 2.90 | 2/54 | [2] | | [2] | |
| 321–322 | Textile | 1/146 | [2] | | [2] | | 9/132 | 2.60* | 1.03–6.55 | 1.37 | 2.11 |
| 5000 | Construction | 4/290 | 0.66 | 0.22–1.95 | 0.51 | 1.02 | 0/15 | [2] | | [2] | |

*Significantly different from 1.
[1]Never employed in a wood- or leather-related occupation.
[2]Not calculated, fewer than three cases.

directly from the questionnaires. The consequence would be a lack of power in detecting true associations.

The consistency of the results across studies was examined because exposure to specific agents in the same occupation might be dependent on the country. Important discrepancies between studies were not observed in situations where there were a sufficient number of cases in multiple studies for comparison. However, even with a large number of subjects in the pooled data set, the number of cases in individual studies for many occupations was small and limited the comparisons between studies. In particular, the relationship with duration of exposure, or changes in OR taking into account an induction period could not be investigated in detail.

The results cannot be explained by confounding effects of tobacco consumption, since preliminary analysis indicated that control of smoking had negligible effects.

It must be noted that the OR estimated for a particular occupation contrasts this occupation with all other occupations, wood and leather workers excluded regarding adenocarcinomas, and not with a population for which there is no a priori suspicion of any cancer risk. With this approach, weak effects are difficult to assess.

It is difficult to rule out the role of wood and leather dust exposures in studies of sinonasal adenocarcinoma. Even though this analysis was restricted to subjects never employed in a wood or leather occupation, low level of exposure to wood or leather dust may have been possible in some occupations, such as salesmen, motor-vehicle drivers, and farmers. In a previous analysis of this pooled data set and two of the individual studies, a large excess risk for adenocarcinoma was only observed among workers classified as having the highest exposure [Demers et al., 1995; Hayes et al., 1986; Leclerc et al., 1994]. For squamous cell carcinomas, which form the largest part of cases, confounding from wood dust exposure is probably negligible.

A number of associations were observed among the occupations and industries for which there was an a priori suspicion. An excess of sinonasal cancer among agricultural workers, limited to squamous cell carcinoma, has been observed in several studies not included in this analysis [Ng, 1986; Takasaka et al., 1987; Bimbi et al., 1988]. In the present study, excesses were observed for squamous cell carcinoma among both men and women and adenocarcinomas among men.

Several studies outside this analysis have observed an excess of sinonasal cancer among textile workers [Acheson et al., 1981; Malker et al., 1986; Ng, 1986; Bimbi et al., 1988]. Among the studies included in the pooled analysis, both positive [Brinton et al., 1985; Comba et al., 1992] and negative [Magnani et al., 1993] associations have been observed. In this study, positive results for adenocarcinoma among women and squamous cell carcinoma among men were observed. However, there was no trend according to duration.

Elevated risks for both histologic types were observed in this study among men employed in food manufacturing or as food preservers. Individual studies have not been of sufficient size to permit conclusions to be made regarding these occupations. In the French study [Luce et al., 1992], the excess was observed for bakers, pastry cooks and grain millers, which was in accordance with Acheson et al. [1981]. The results in the pooled reanalyses are close to previous observations from Olsen [1988] regarding excesses among female employees in canning and preserving fruits and vegetables and among employees of both sexes in cocoa,

chocolate, and sugar confectionery. A potentially related excess was observed among men employed as cooks. An excess of squamous cell carcinoma was observed and was consistent between studies, but no excess was observed among women.

A positive association with squamous cell carcinoma was observed for male transport equipment operators. An association with adenocarcinoma was also observed among male motor-vehicle drivers, a subcategory of transport equipment operators. Malker et al. [1986] has observed similar associations. None of the individual studies included in the pooled data set found a significant association for these occupations. The one study (Virginia) which contributed to a large part to the results for adenocarcinoma did not contribute to the results for squamous cell carcinoma.

A number of associations were also observed in the systematic analysis which require further investigation. An excess of squamous cell carcinoma among hairdressers was observed, but was limited to males. Fifteen female controls, but no female squamous cell carcinoma cases had been employed in this occupation. Occupational exposure among hairdressers may differ according to sex, since more male hairdressers (both cases and controls) were employed as barbers than as women's hairdressers. The excess among rubber and plastic product makers, and especially in tire manufacturing, was also unexpected. However, Bernardinelli et al. [1987] in a cohort study of rubber-factory workers found a significant excess of mortality for maxillary sinus, based on one case.

Non-significant elevated odds-ratios were observed among both male and female sales, shop assistants, and related workers for squamous cell carcinoma, and a significant association for males between adenocarcinoma and employment as technical, salesmen, and commercial travelers. The excess could not be observed with separate analysis of the studies. A large number of occupational exposures can be found in these occupations, including wood dust, textile dust, and other organic dusts.

Other positive associations observed in this analysis are less clear. Some occupational groups entail various occupational exposures, such as commercial artists and designers, miners and quarrymen, and stationary engine operators; other results originate from one or a few studies, which indicates that they might be due to chance or reflect a situation specific to one region more than an excess for this occupation per se.

This reanalysis did not confirm previous results about metal workers (possibly at risk since they might be exposed to known carcinogens such as nickel and chromium) and construction workers (exposed to mineral dusts, and also possibly to wood dust).

Many occupations with an increased risk in this study may be considered as exposed to organic dusts in general, which would be consistent with the known effects of wood and leather dusts [Engzell et al., 1978]. The list includes textile workers, farmers and agricultural workers, and people handling food. No excess was observed, however, among bakers or other workers exposed to flour.

The major objective of this reanalysis was to overcome the difficulties due to a small number of subjects in individual studies. This objective has been reached in the sense that the results are more informative than the sum of results from individual studies. Further analyses based on substances such as different types of organic dusts (flour, grain, type of textile) and formaldehyde [Luce et al., 1993] could lead to a better understanding of the results.

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**APPENDIX 1.** Squamous Cell Carcinoma—Systematic Analysis: Additional Results in Reanalysis of 12 Studies of Sinonasal Cancer

| | | Males (330 cases, 2349 controls) Ever employed | | | Females (102 cases, 787 controls) Ever employed | | |
|---|---|---|---|---|---|---|---|
| ISCO code | Short name | Cases/controls | OR | 95% CI | Cases/controls | OR | 95% CI |
| 14 | Religion workers | 3/10 | 1.84 | 0.47–7.20 | 1/1 | [1] | |
| 2 | Administrative | 10/78 | 1.16 | 0.57–2.35 | 0/2 | [1] | |
| 3 | Clerical workers | 11/87 | 0.85 | 0.44–1.66 | 0/10 | [1] | |
| 30 | Clerical supervisors | 3/21 | 0.73 | 0.21–2.50 | 0/9 | [1] | |
| 31 | Government executives | 6/31 | 1.50 | 0.60–3.76 | 1/6 | [1] | |
| 32 | Typist | 5/65 | 0.46 | 0.18–1.17 | 12/97 | 1.00 | 0.49–2.02 |
| 33 | Bookkeeper | 8/75 | 0.55 | 0.26–1.17 | 10/71 | 1.74 | 0.79–3.82 |
| 37 | Mail | 8/46 | 0.96 | 0.44–2.11 | 1/11 | [1] | |
| 39 | Clerk | 25/180 | 0.85 | 0.54–1.34 | 6/102 | 0.50 | 0.20–1.24 |
| 40 | Managers | 4/26 | 1.42 | 0.46–4.34 | 0/12 | [1] | |
| 41 | Proprietors | 6/38 | 0.81 | 0.33–1.99 | 0/5 | [1] | |
| 42 | Sales supervisors | 11/62 | 1.36 | 0.68–2.73 | 1/8 | [1] | |
| 43 | Sales-travelers | 9/64 | 1.06 | 0.51–2.19 | 0/8 | [1] | |
| 44 | Insurance | 9/46 | 1.35 | 0.62–2.93 | 1/10 | [1] | |
| 50 | Managers-cat. | 5/19 | 2.24 | 0.78–6.46 | 2/10 | [1] | |
| 51 | Prop-cat. | 4/9 | 2.20 | 0.66–7.35 | 0/5 | [1] | |
| 53 | Waiters | 19/82 | 1.42 | 0.82–2.44 | 12/108 | 0.90 | 0.45–1.78 |
| 54 | Maids | 0/7 | [1] | | 12/84 | 0.64 | 0.30–1.38 |
| 55 | Charworkers | 12/72 | 1.00 | 0.52–1.92 | 3/36 | 0.50 | 0.14–1.73 |
| 56 | Launderers | 1/15 | [1] | | 3/19 | 1.14 | 0.31–4.16 |
| 58 | Protective service | 42/218 | 0.94 | 0.64–1.39 | 1/8 | [1] | |
| 59 | Service | 11/85 | 1.12 | 0.56–2.24 | 3/67 | 0.47 | 0.14–1.58 |
| 611 + 621 | Farm, general | 62/393 | 1.08 | 0.79–1.48 | 14/53 | 1.59 | 0.81–3.11 |
| 61220 + 622 | Farm, field crop | 20/99 | 0.86 | 0.51–1.47 | 8/27 | 1.73 | 0.70–4.30 |
| 61240 + 624 | Farm, livestock | 7/40 | 1.15 | 0.50–2.68 | 1/5 | [1] | |
| 61270 + 627 | Farm, nursery | 8/47 | 1.21 | 0.55–2.68 | 0/4 | [1] | |
| 63 | Forestry | 23/262 | 0.94 | 0.57–1.53 | 0/3 | [1] | |
| 70 | Foremen | 10/93 | 0.63 | 0.32–1.24 | 1/4 | [1] | |
| 72 | Metal | 14/89 | 1.14 | 0.63–2.09 | 1/7 | [1] | |
| 73 | Wood preparation | 17/143 | 1.17 | 0.67–2.04 | 1/6 | [1] | |
| 74 | Chemical | 6/37 | 0.99 | 0.40–2.41 | 1/6 | [1] | |
| 75 | Textile | 17/83 | 1.39 | 0.78–2.48 | 13/86 | 1.23 | 0.62–2.43 |
| 76 | Leather | 3/10 | 2.61 | 0.67–10.1 | 0/3 | [1] | |
| 79 | Tailors | 5/31 | 0.97 | 0.37–2.59 | 5/59 | 0.57 | 0.22–1.50 |
| 80 | Shoemakers | 8/37 | 1.67 | 0.74–3.78 | 2/14 | [1] | |
| 81 | Cabinet makers | 10/67 | 1.02 | 0.51–2.05 | 2/6 | [1] | |
| 83 | Blacksmiths | 23/150 | 1.14 | 0.71–1.83 | 1/16 | [1] | |
| 84 | Machine fitters | 41/254 | 1.06 | 0.73–1.54 | 1/11 | [1] | |
| 85 | Electrical fitters | 14/126 | 0.91 | 0.50–1.64 | 3/15 | 1.93 | 0.50–7.46 |
| 87 | Plumbers, welders | 18/140 | 0.96 | 0.57–1.62 | 2/12 | [1] | |
| 89 | Glass | 4/36 | 0.68 | 0.23–1.96 | 0/1 | [1] | |
| 92 | Printers | 4/42 | 0.66 | 0.23–1.91 | 0/5 | [1] | |
| 93 | Painters | 7/57 | 0.79 | 0.35–1.79 | 0/5 | [1] | |
| 94 | Production workers | 4/36 | 1.02 | 0.35–2.99 | 2/28 | [1] | |
| 95 | Construction | 38/325 | 0.90 | 0.62–1.31 | 0/6 | [1] | |
| 97 | Dockers | 32/247 | 0.79 | 0.52–1.18 | 0/44 | [1] | |
| 99 | Laborers n.e.c. | 42/260 | 1.17 | 0.80–1.69 | 3/20 | 0.87 | 0.24–3.23 |

[1]Not calculated, fewer than three cases.

**APPENDIX 2.** Adenocarcinoma—Systematic Analysis: Additional Results in Reanalysis of 12 Studies of Sinonasal Cancer

| | | Males[1] (33 cases, 1707 controls) Ever employed | | | Females[1] (23 cases, 727 controls) Ever employed | | |
|---|---|---|---|---|---|---|---|
| ISCO code | Short name | Cases/controls | OR | 95% CI | Cases/controls | OR | 95% CI |
| 45 | Salesmen | 6/169 | 2.05 | 0.80–5.27 | 1/116 | [2] | |
| 54 | Maids | 0/6 | [2] | | 3/78 | 0.69 | 0.17–2.79 |
| 58 | Protective Service | 3/177 | 0.75 | 0.21–2.66 | 0/6 | [2] | |
| 61220 + 622 | Farm, field crop | 2/75 | [2] | | 3/26 | 1.86 | 0.47–7.41 |
| 75 | Textile | 0/69 | [2] | | 5/83 | 1.82 | 0.60–5.51 |
| 79 | Tailors | 0/19 | [2] | | 4/49 | 1.51 | 0.79–7.99 |
| 83 | Blacksmiths | 3/119 | 1.67 | 0.48–5.74 | 0/13 | [2] | |
| 84 | Machine fitters | 5/198 | 1.57 | 0.58–4.27 | 1/9 | [2] | |
| 97 | Dockers | 3/177 | 0.79 | 0.23–2.69 | 1/38 | [2] | |

[1]Never employed in a wood- or leather-related occupation.
[2]Not calculated, fewer than 3 cases.